FRICTION OPTIMIZATION THROUGH MASS FINISHING: IMPROVING RUN-IN AND FRICTION BEHAVIOR AND STRENGTH

AGENDA

1 OTEC Streamfinish technology

2 Mechanical frictional conditioning

3 Friction results and analysis

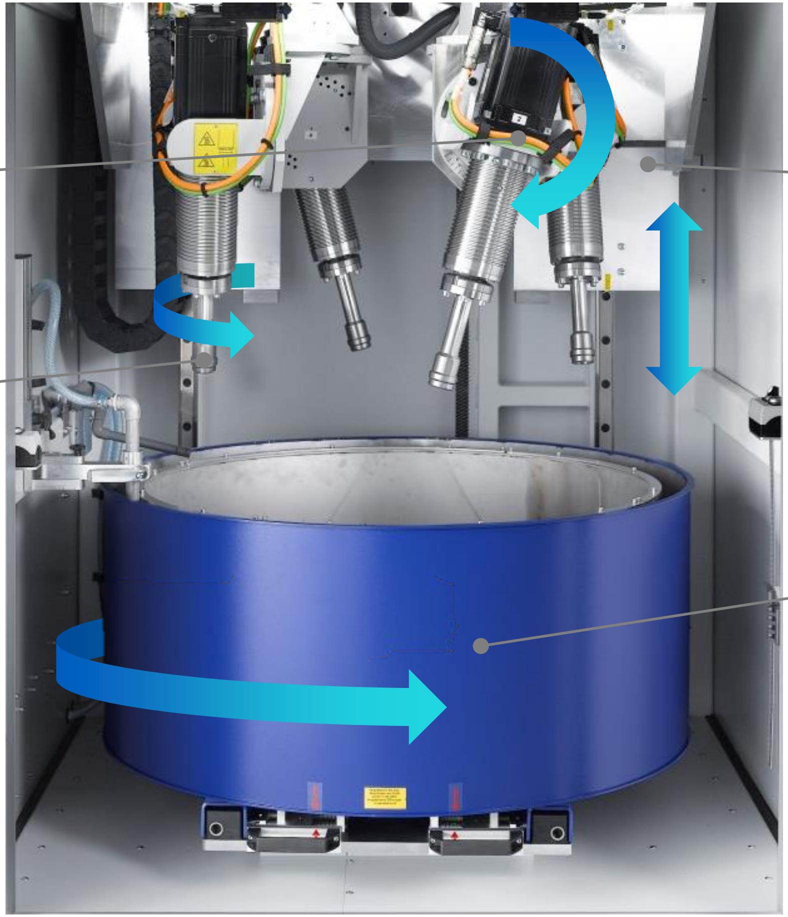
4 Treatment of gears

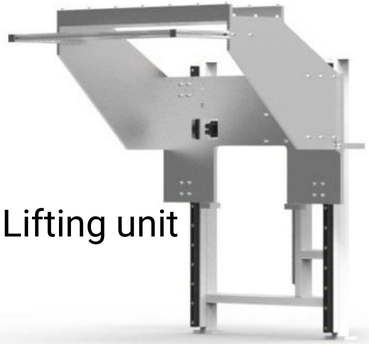
STREAM FINISHING MACHINE

Principle

Angular adjustment for work piece holder (immersion angle)

Rotating workpiece holder



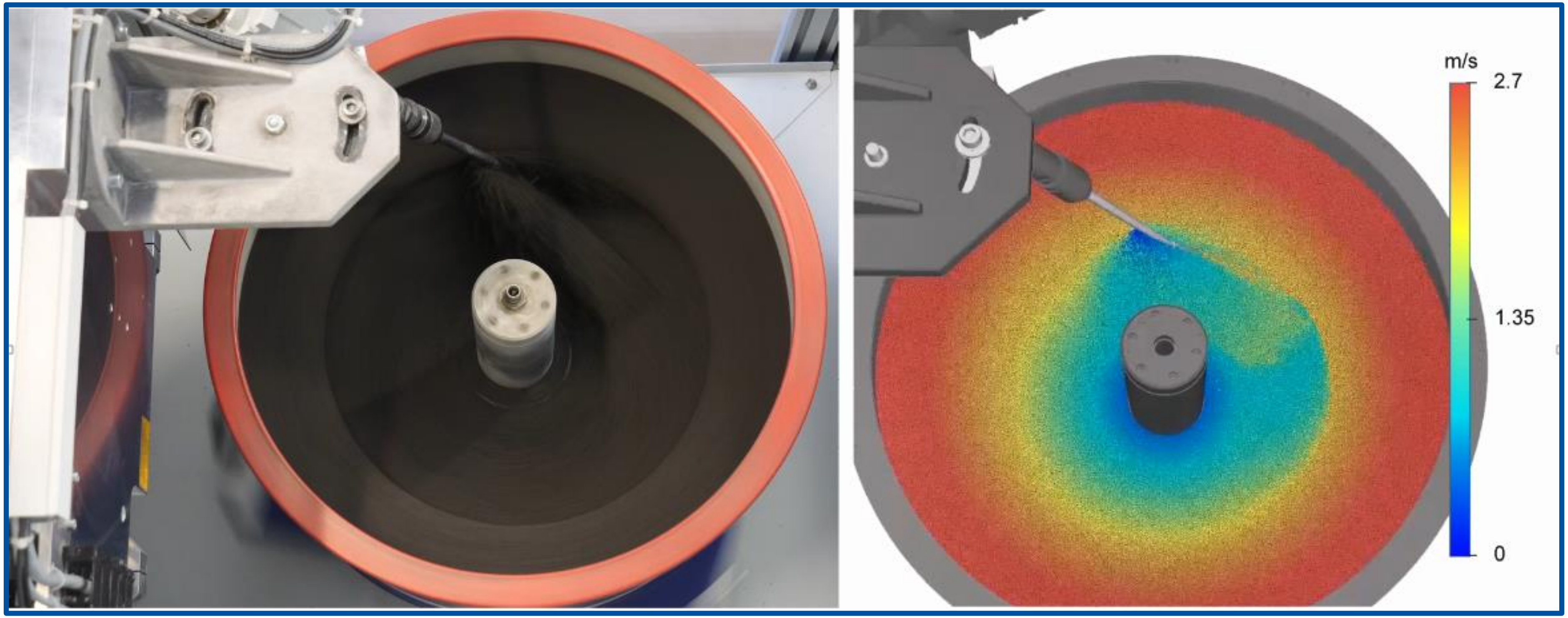


Lifting unit

Rotating process container filled with abrasive media

STREAMFINISH PROCESS

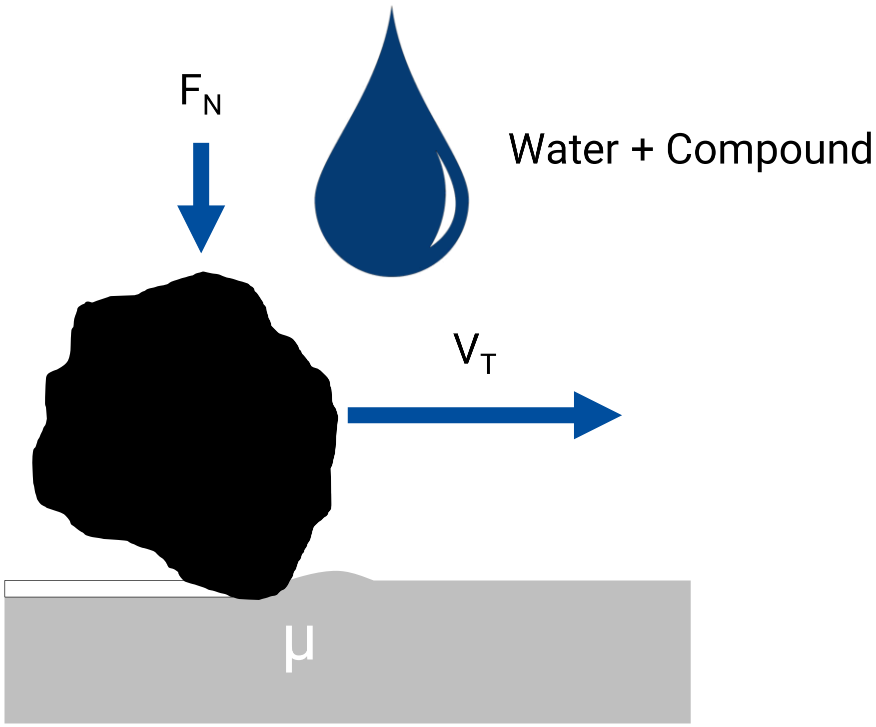
Descrete Element Method Simulation



SURFACE EFFECT OF STREAMFINISH

Streamfinish is a friction load…

- Intentional abrasion → Roughness reduction
- Small surface deformation and plasticization
- Shear stresses → **Grain structure modification**
- Friction energy → **Frictional conditioning**



$$\mathbf{P_F} = F_N \cdot V_T \cdot \mu$$

FRICTIONAL CONDITIONING

Third-Body – The better friction surface

High frictional energy input of the process leads to:

Easy-to-shear layer:

- Impurities in the boundary layer(→AES graph)
- Only a few nm thick
- Layer is easy to deform

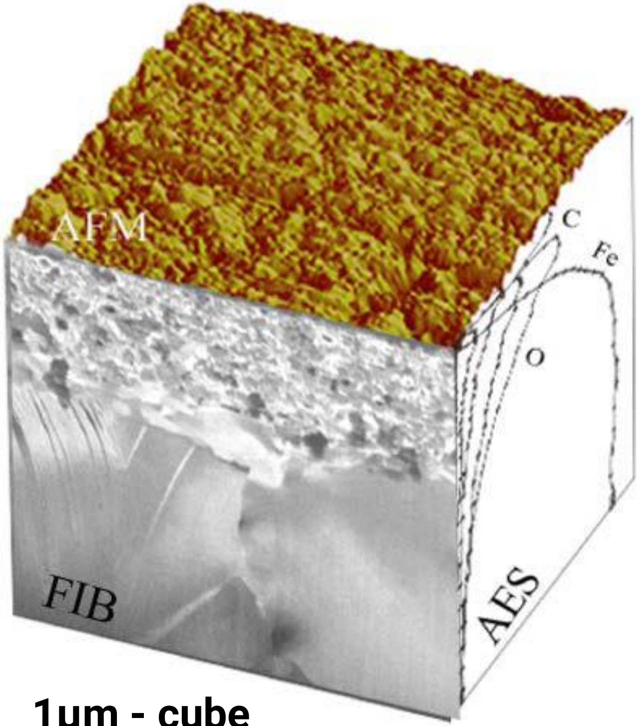
→ **Reduced coefficient of friction**

Easy-to-shear layer:

- Impurities in the boundary layer(→FIB picture)
- Only a few nm thick
- Layer is easy to deform

→ **Reduced coefficient of friction**

3rd body

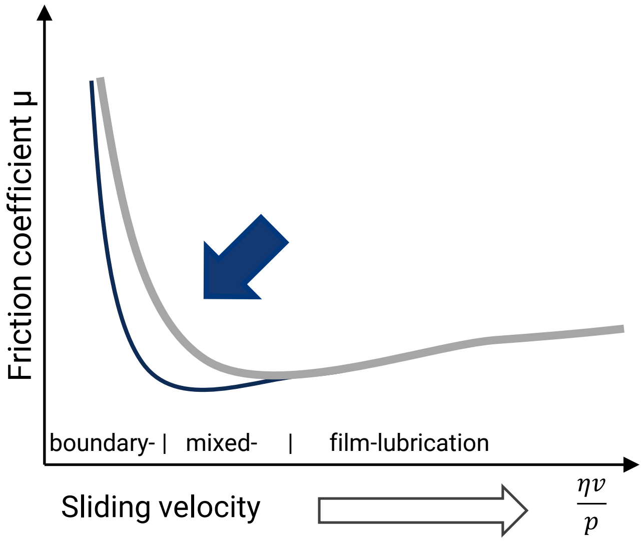


1µm - cube
source: µTC Karlsruhe

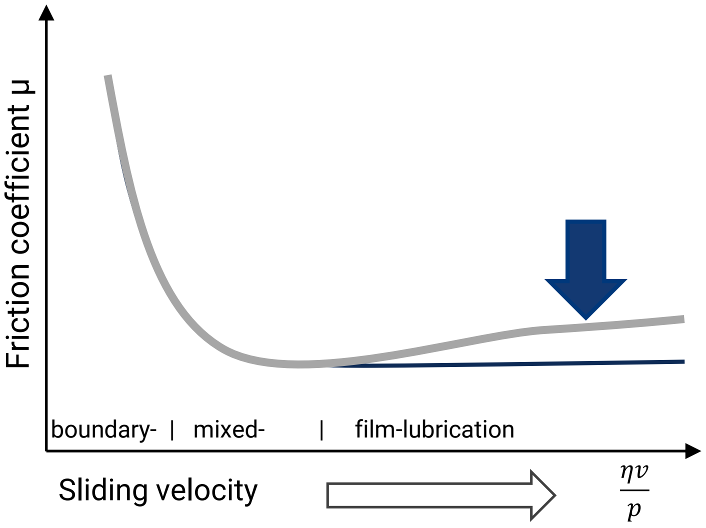
Third-body “grows” in the surface by continuingly provided friction energy – it‘s not lost by wear

FRICTIONAL CONDITIONING: FINSHING BENEFITS

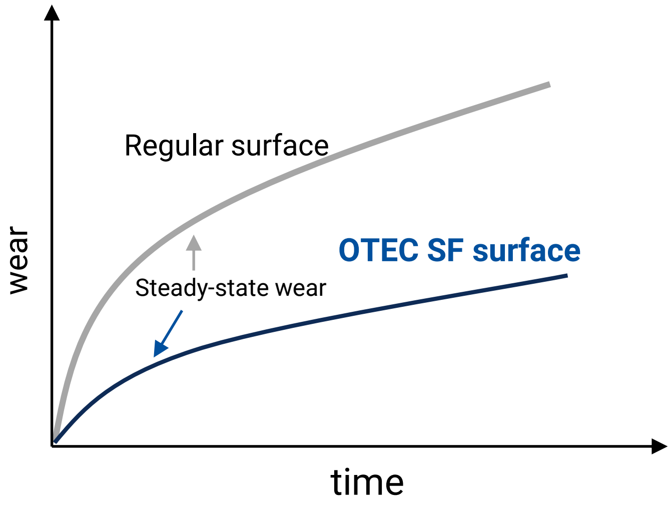
Reduced friction and wear



- Reduced roughness peaks
- Improved lubrication film strength
- Clearly **less proportion of boundary friction**



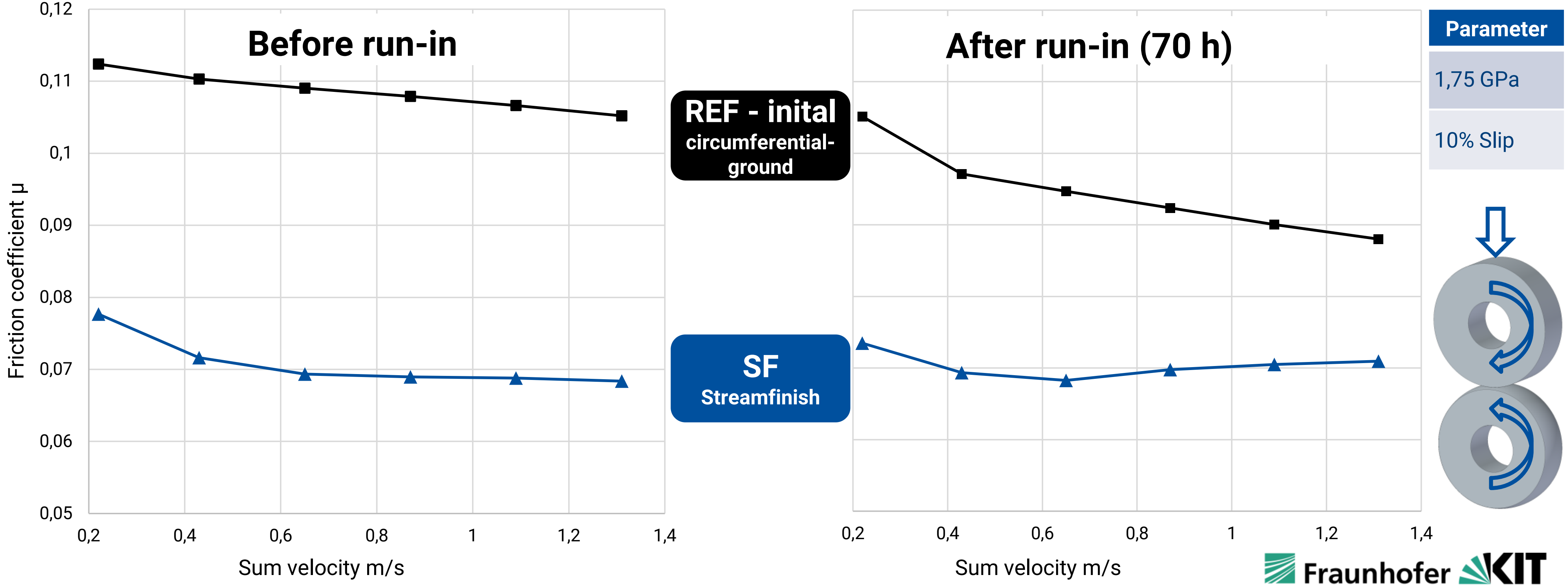
- Reduced peak provides use of **low viscosity oil** for **similar contact conditions**

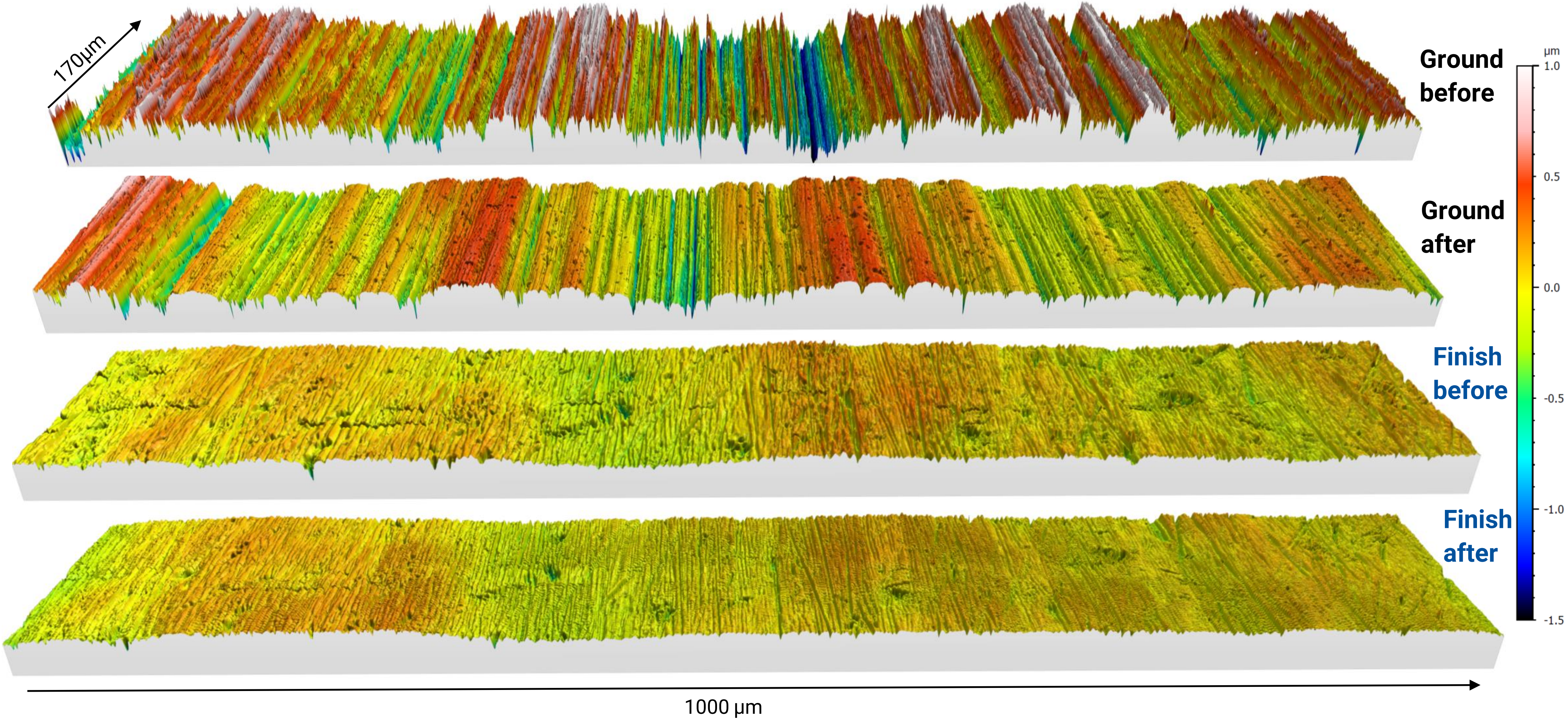


- Finish acts as run-in-like treatment
- *Third Body* **reduces friction and wear**
- Stable wear corridor
- No separate running-in necessary

FRICTION TEST BENCH RESULTS

Amsler twin-disk test - results



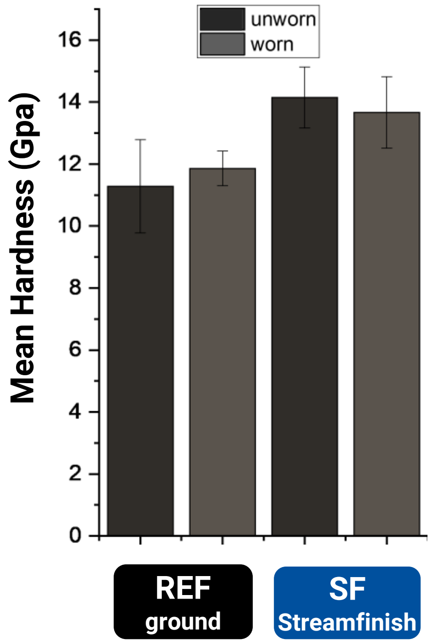

170µm
Ground before
Ground after
Finish before
Finish after
µm
1.0
0.5
0.0
-0.5
-1.0
-1.5
1000 µm

MICRO-HARDNESS INCREASEMENT

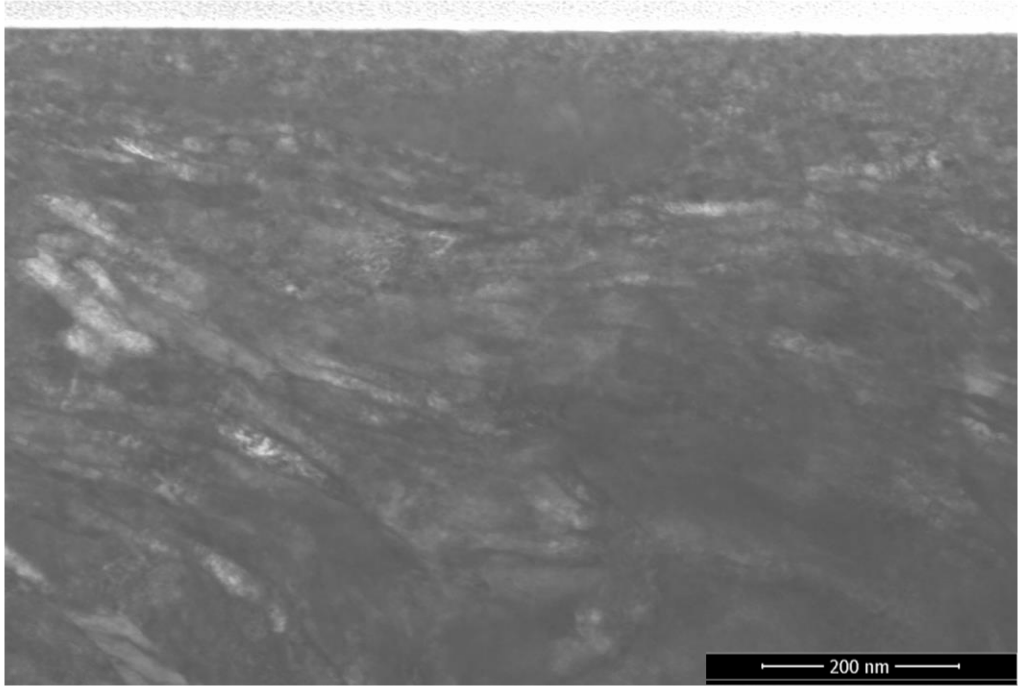
Amsler twin-disk – FIB and T-SEM

- Streamfinish shows 10-15% **higher Hardness** of the boundary layer
- No clear load influence
- **Nanocrystalline structure** in the first 100 nm
- Clear grain size gradient visible

Nanoindentation:



FIB + T-SEM, **SF**:



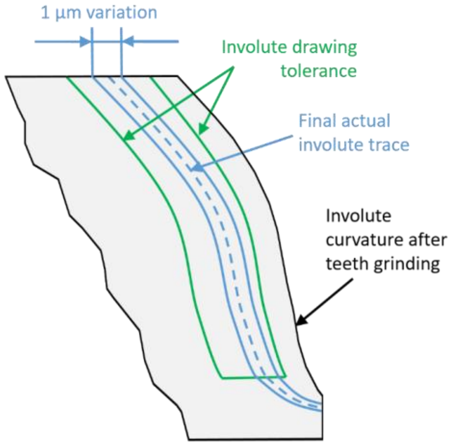
Fraunhofer KIT
Karlsruher Institut für Technologie
MIKROTRIBOLOGIE CENTRUM µTC

OTEC
PRECISION FINISHING SOLUTIONS

TREATMENT OF GEARS

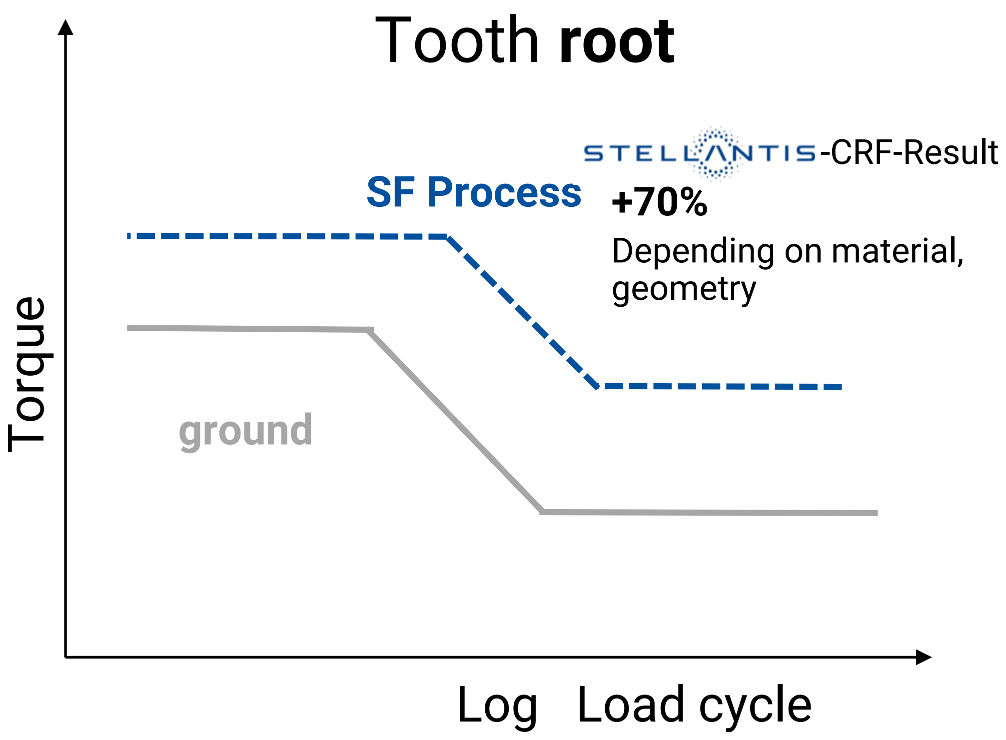
Effective integral processing solution

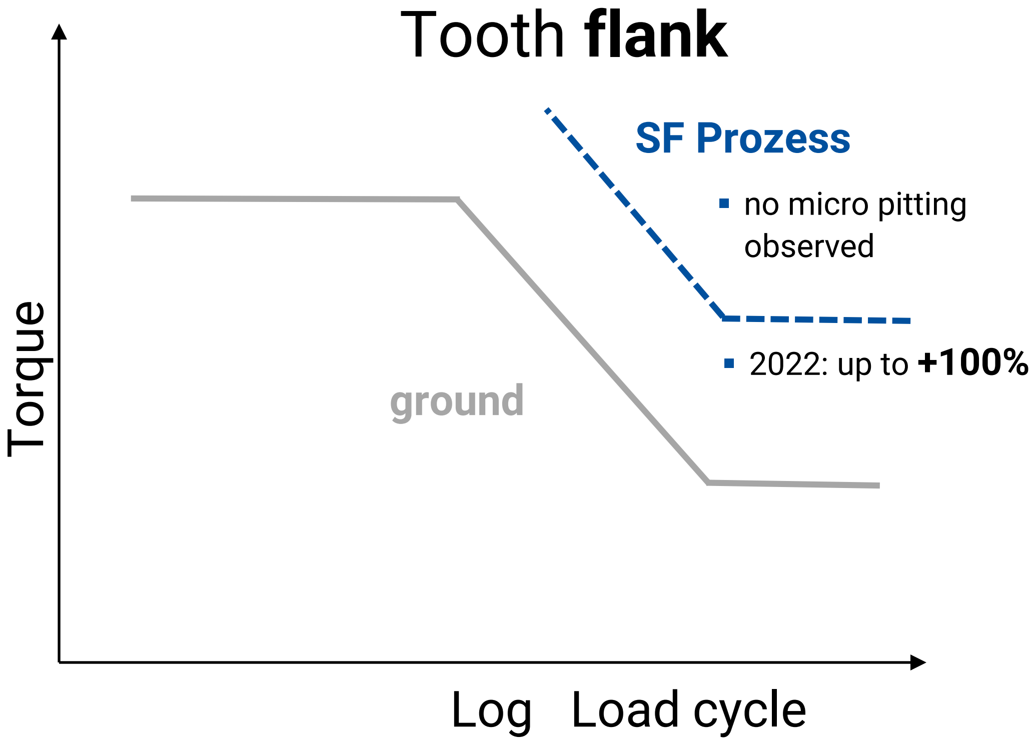
- Extremely low process variation (1 µm) compared to other processes (~5-10 µm)
- No handling of hazardous chemicals
- Minimized risk of lubricant film breakage due to introduction of microscopic lubrication pockets
- Significant improved surface isotropy
- Reduced roughness peaks, mirror like surface using dry polishing
- Less wear, accelerated running-in, longer oil life
- Low risk of micro-pitting
- Reaching into smallest geometries, thanks to very fine media
- Fast process time (ca. 60s per part and machine)
- Cost-effective process: thanks to closed-loop operation and no cost-intensive disposal
- Fast & efficient: deburring, edge rounding & smoothing in one step



TREATMENT OF GEARS

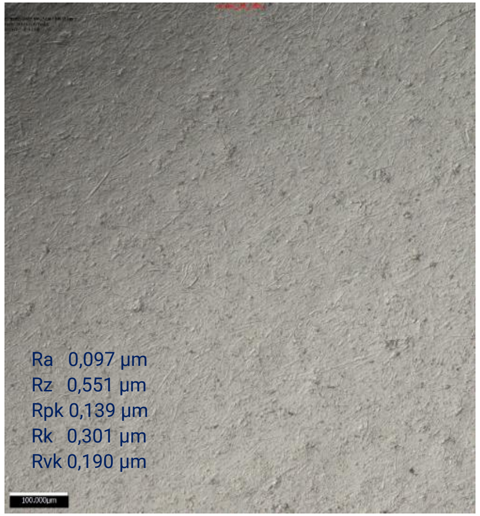
Improved strength





CONCLUSION

- Fast and controlled run-in after finishing
- Roughness level determining for the tribo-performance
- This lever can be adjusted according specific tribological requirements
- Sample treatments in our Finishing Center for process development



OTEC
PRECISION FINISHING SOLUTIONS

THANK YOU FOR YOUR ATTENTION!